Development of a Black Rockfish Population Index

OPERATIONAL PLAN FOR YEAR 2004 IN-THE-WATER ROCKFISH ASSESSMENT

This document is part of compliance of sec. 2.21
Alaska Department of Fish and Game
Manual for Scientific Diving Safety

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INTRODUCTION

Approximately 35 species of rockfishes (genera *Sebastes* and *Sebastolobus*) occur in marine waters off the coast of Alaska (Kramer and O'Connell 1995; Mecklenburg 2002). Rockfish can generally be grouped into one of several assemblages based on similarities in behavior and distribution. In nearshore waters, some species are often found around high-relief substrate and can occur in dense feeding aggregations at the sea surface. These nearshore species, grouped into the pelagic shelf assemblage, are an integral component of the commercial, recreational, and subsistence fisheries prosecuted by shore-based fleets in southcentral Alaska (Trowbridge et al. 2001; Alaska Department of Fish and Game 1999; Berceli et al. 1999; Meyer 1999). These fisheries have become increasingly important to the economic and cultural base of coastal communities.

Nearshore rockfish assessment continues to be problematic due to rockfish behavior, life history, and habitat preferences (Phillips 1994; Bechtol 1998, 2000). Although rockfish aggregations may be easily located and harvested, the strong association of pelagic shelf rockfish with high-relief habitat makes assessment, particularly abundance estimation, difficult. As a result, management approaches typically rely on historical harvest patterns (Bechtol 1992). In the absence of abundance data, rockfish resources may be overfished or, conversely, conservatively managed for substantially less than potential sustainable production. Assessment of nearshore rockfish requires innovative approaches and, most likely, a combination of assessment techniques.

The study will focus on black rockfish *Sebastes melanops*, one of the most frequently harvested nearshore rockfish species, but other nearshore species will be enumerated as encountered. In situ observations using SCUBA will be used to develop sampling techniques to index shallow water component of the black rockfish population along the northern Gulf of Alaska. In addition, catch-per-unit-effort will be assessed as a measure of a relative index of abundance. This project is supported by a grant administered through the National Oceanic and Atmospheric Administration (NOAA).

This project plan is presented in two sections. The first section of this document presents an overview of the project including objectives, field procedures, and data analyses. As per provisions of the ADF&G ***Manual for Scientific Diving Safety*, Section 2.21, Dive Plan**, (ADF&G 2002), the second section of this document is submitted as the dive plan for the Outer Kenai Rockfish Assessment Project. The dive plan section describes project dive operations, including the general nature of the project as it concerns diving, potential dive hazards peculiar to this project, and specific project dive protocols. This second section also provides reference material describing injuries specific to diving and relative topics.

I. PROJECT OVERVIEW

The primary goal of this two-year study is to develop a method to index and monitor status of black rockfish *Sebastes melanops* resources in coastal areas of the Gulf of Alaska. Current management strategies are largely based on historical harvest levels. However, there is a high degree of uncertainty in both the accuracy of historical data and in whether historical harvest levels are appropriate for current stock levels under existing environmental and ecological conditions. This research is needed to improve assessment and management precision in the presence of this increased uncertainty. This project will build upon and supplement results from prior Nearshore Marine Research projects.

The proposed project will compare population indices developed from jigging and hydroacoustics surveys. Jigging catch-per-unit-effort (CPUE) will be evaluated by ADF&G Region II (Homer) groundfish staff and hydroacoustics estimates will be made by Region IV (Kodiak) staff. If successful, this method will be a cost effective means of providing an index of relative abundance that can be implemented across Alaska's management regions.

Background

Previous black rockfish research projects funded through Nearshore Marine Research grants have attempted to develop methods to assess black rockfish populations or better understand population parameters. A black rockfish workshop sponsored by ADF&G in February 2003 brought together ADF&G staff with rockfish experts from outside the state to discuss research priorities and management strategies for black rockfish in Alaska. Key knowledge gaps were identified, prioritized, and then potential assessment techniques were explored. The workshop also identified a need to compare results of these black rockfish research projects among regions. A primary workshop conclusion was that black rockfish population(s) in Alaska could be assessed using an age structured modeling approach, but an index of abundance is needed first. A fishery independent CPUE index from a mechanical jigging survey, a biomass estimate using hydroacoustics, and a density index based on scuba observations were identified as candidate indices.

Any index should be robust to detecting changes in the relative abundance of black rockfish populations spatially on the scale of management areas, and temporally over a series of years. In the case of CPUE, often the relationship is not proportional and CPUE may remain high while abundance declines. Therefore, it is essential to identify the functional relationship (e.g. power or asymptotic) between CPUE and abundance.

Project Goals and Objectives

This two-year project is a cooperative effort between staffs from ADF&G's Central and Westward Regions. The goal of this two-year project is to develop and implement a sampling

approach to index and monitor the status of black rockfish resources in coastal areas of the Gulf of Alaska. The objectives are identified to tasks as follows:

Task 1a. Compare mechanical jigging CPUE to relative density from timed counts using scuba and test for relationship between the two indexes.

Task 1b. Develop a hydroacoustic-based method of estimating black rockfish biomass.

Task 2. Compare jig-based CPUE estimates, hydroacoustic-based biomass estimates, and scuba-based density estimates of black rockfish.

Objectives

This two-year project is a cooperative effort between staffs from ADF&G's Central and Westward Regions. The goal of this two-year project is to develop and implement a sampling approach to index and monitor the status of black rockfish resources in coastal areas of the Gulf of Alaska.

Central Region staff objectives for the 2004 rockfish assessment survey are to:

1. Collect catch and effort data to determine if catch-per-unit-effort can be used as an index of relative abundance;
2. Collect biological sample data to assess spatial differences in black rockfish size, sex, and age;
3. Use timed counts by scuba divers to collect relative density estimates of black rockfish; and
4. Compare mechanical jigging CPUE to scuba index counts and test for relationships between the two indices.

Study Area

The summer 2004 survey will be conducted along the outer coast of the Kenai Peninsula in the northern Gulf of Alaska (Figure 1). This area was previously sampled with particular attention placed on Harris Bay and Nuka Island (Byerly and Bechtol *under review*). Results from a previous study indicated that high energy shorelines composed of large boulder (1 to 3m in dia.) and block (boulders > 3m dia.) habitats are strongly significant predictors of black rockfish occurrence. Therefore, the 2004 sample sites will focus on these habitat types.

Methods and Approach

Task 1a. Region II, Homer: Test for relationship between mechanical jigging CPUE and density.

We will compare black rockfish relative density estimates from SCUBA timed counts with mechanical jigging CPUE to assess the dependence of black rockfish CPUE on relative density. It is assumed that the relative density estimates reflect the true black rockfish density. This study will be located along the outer coast of the Kenai Peninsula in the Northern Gulf District (NGD) of the Cook Inlet Management Area (CIMA). Approximately ninety percent of the CIMA commercial black rockfish harvest occurs in the NGD. Sampling sites will be distributed throughout the NGD with replicate samples taken at each site. By distributing effort across a large area, a range of black rockfish densities should be encountered, thus adding contrast to the data. Should the results from this study indicate that a relationship between black rockfish CPUE and density could be modeled, we will launch a future study to assess the variance in black rockfish CPUE from a mechanical jigging survey. Since jigging effort will be distributed across a large section of the NGD, CPUE collected during this study will serve as pilot data to aid in the design of the future study.

Sixty sampling sites will be distributed along the NGD from the Chiswell Islands to Windy Bay, with three replicate timed counts preformed at each site (Figure 1). Each evening, staff will determine which sites will be sampled the following day. We will attempt to sample eight sites per day. It is important that timed counts be performed as close as possible to the area that is fished by the jig boat and that the time between jigging and diving be brief.

A summary of the daily sequence of diving and fishing operations is given in Appendix I and is described at length here. At each site, the jig boat will visit the site first, locate the appropriate bottom depths (5 to 11 fa), and determine the predominate drift. A drift will be approximately 0.5 nautical miles. The crew on the jig boat will mark the start and end points of the drift with anchored buoys. The jig boat will then proceed to the next site and repeat the procedure. A dive skiff should be on site and ready to dive after the jig boat has marked the site. A dive team will then perform three timed counts along the drift line. The starting location for the first count will be chosen from a random number. This number will be the distance in meters from the up current buoy. The following counts will be spaced approximately 300 m apart working towards the down current buoy. Relative density for a site will be estimated as the peak count of black rockfish recorded during a five-minute count. Previous work has shown that black rockfish counts peak around three minutes (Nearshore Marine II, Northern Gulf of Alaska Rockfish Assessment). Once at a site, a dive team will descend directly to the bottom and immediately start counting all individual black rockfish present (time 0). Subsequent counts will be made every minute for a total of five minutes (times 1 to 4). In addition to counting fish, each diver should record the horizontal visibility (m), primary and secondary substrate type, and maximum vertical relief (m) (Appendix II). After the five-minute counting period, divers will ascend and move to the next location within the site to perform a replicate dive. Site specific data will be recorded by the dive tender with an Allego hand held computer running Dataplus using the application TCHEADER (Appendix III).

After the dive team has completed the timed counts, the jig boat will return to the site and jig for black rockfish along the drift line for 30 minutes. Standard black rockfish commercial fishing terminal fishing gear consisting of ten 11/0 cod hooks with black rubber tubing fished from mechanical jigging machines will be used. Catch for each site will be recorded as a function of the cumulative time spent fishing at a site. Total effort at each site will be calculated as the total

time spent actively fishing at each site, and catch as the total number of black rockfish captured per hooks fished. CPUE data will be recorded with an Allego hand held computer running Dataplus using the application RFCPUE (Appendix IV). Every 10^{th} black rockfish captured will be retained for biological sampling. Data collected will include, fork length (cm), weight (0.1 kg), sex, maturity, and removal of otoliths. Biological data will be recorded with an Allego hand held computer running Dataplus using the application GAWL.

Relative density and CPUE data will be modeled using the methods of Richards (1987). This generalized model allows the relationship between CPUE and density to be proportional, or depart from proportionality at either low or high densities or both. Further, the model can be used to relate two indices between years or a combination of indices between years.

Task 1b. Region III, Kodiak: Develop a hydroacoustic index.

The evaluation of hydroacoustics as a black rockfish indexing tool will be a three phase process. First, ADF&G personnel will be trained in the operation of the system, including hydroacoustic theory and biomass calculations. Training will include classroom training and field training at the study site. Second, factors affecting fish detection by the system will be investigated, and third, a survey will be repeated five times in the first year to estimate variability of the biomass estimates.

The equipment selected for use in the project is the BioSonics DT-X echosounder and 200 kHz transducer with associated acquisition software. This is a state-of-the-art system which should cover a reasonable volume of water while still maintaining a narrow beam with low side lobes. Narrow beam width and low side lobes are two features which should allow for surveying close to complex bottom relief and still discriminate between the structure and fish. Training by Biosonics staff will be included as part of the purchase price.

After Kodiak staff has become proficient in operation of the equipment, field testing of the equipment will begin. The study site is located on the north side of Spruce Island, just north of the city of Kodiak and is a known area of black rockfish aggregations. The approximately 5 km^2 site is bounded by deep muddy substrate on all sides minimizing migration of fish from the area. It is close enough to the city of Kodiak that surveys of the area can be completed in a day, eliminating the need for premium overnight sea duty pay. A high priority for field testing is determining when black rockfish are at a maximum availability to the system (Foote and Stefansson 1993). Interviews with fishermen have identified the tide cycle and the diel cycle as two factors which may affect when fish are up in the water column and most detectable by the echsosounder.

To investigate these two factors, an initial survey of the area will be used to locate black rockfish schools and field test gear through repeated transects. Fish will be sampled with video gear and jig machines to insure target ID and to develop a target strength for black rockfish. A smaller sub-area with concentrated black rockfish schools will be selected for more intensive surveying. Previous work has shown black rockfish schools to persist within a fairly small area (Dan Urban, unpublished data). To determine the change in configuration of the rockfish schools within the tide cycle, the study sub-area will be re-surveyed every hour for 12 hours during a period of

maximum ebb and flood of tide to determine the period of maximum biomass estimation. Diel movements will be investigated during a period a minimal tide flow by re-surveying every hour over two 6 hour periods covering dawn and dusk, again to determine the period of maximum biomass estimation. The hourly sampling of diel and tidal fish distributions will be repeated 3 times.

After determining variability associated with the tidal and diel cycles, a survey of the larger area will be timed so that the maximum amount of fish can expected to be detectable by the equipment. Five hydroacoustic surveys of the larger area will be made over a 10-day period to determine the repeatability of the biomass estimates. The Biosonics staff will be onsite for both the field testing of the equipment and the initial survey of the Spruce Island site.

Task 2. Regions II and III: Joint SCUBA, mechanical jigging, and hydroacoustic survey

Tasks 1a and 1b will be combined in year two in order to assess trends in the two indexing methods. The sampling locations and design from Task 1a in FY04 will be duplicated in FY05. Using the commercial jig vessel, three replicate hydroacoustic biomass surveys will be preformed at each location prior to the diving operation. The methods will follow those developed in Task 1b. Black rockfish relative density, CPUE, and hydroacoustic biomass estimates will be compared at each location and the relative statistical efficiency of the acoustic and jig estimates will evaluated.

II. DIVE PLAN

Project Location

Fieldwork for this project occurs at remote locations along the outer Kenai Peninsula in the northern Gulf of Alaska (Figures 1, 2, and 3). Specific study sites, described more thoroughly in Section I of this project plan, include both portions of exposed coastline and more protected locations along the interior portions of bays.

Environmental Conditions

During the summer, air temperature ranges from a mean daily minimum of about 40°F to a mean daily maximum of about 60°F along the Gulf of Alaska coast. Water temperature ranges from about 36°F to 50°F except at the heads of glacially-influenced bays where temperatures may be cooler and icebergs may be present. Storms are not uncommon and periods of inclement weather

can be expected. Much of the coastal area is influenced by strong tidal currents and can also be affected by a predominately westerly coastal current.

Logistical Support

Due to the remote locations for this project, fieldwork is supported by the 66-ft ADF&G research vessel *Pandalus*. This vessel will be equipped with extensive first aid resources; sophisticated high-powered communication and navigation equipment; hot-water showers; a dive locker; dive compressors; and other amenities for the divers. The support vessel will transport two skiffs that support the actual diving operations. A dive tender will operate each skiff. The mother support vessel will communicate with the Homer ADF&G office on a daily basis. Preferred contact is via satellite email or satellite phone. Alternative contact is single sideband radio on frequency 3230.0 mHz at approximately 0915 and 1615 hrs, or at another time and frequency coordinated between the vessel operator and the Homer ADF&G office staff.

Dive Logistics

The diving involved in this project is relatively fundamental for divers accustomed to diving in Alaska coastal waters. Project diving involves standard SCUBA protocols, the use of dry suits, underwater field recording equipment, and underwater video equipment. Dive teams will consist of no less than two divers, comprised of a designated lead diver and a support diver. Each dive will be coordinated with the divers, dive tenders, and the mother support vessel. Radio contact will be maintained between the dive skiffs and the support vessel. Support vessels will be informed of the specific dive location, when the divers enter the water, and when the divers are retrieved. Typically, fewer than ten dives are made per day. Physiological stresses upon divers during similar projects in 1983, 1984, and 2001-2003 were minimal.

Diving protocols

1. **All diving for this project will be done in strict accordance with protocols established to optimize diver safety and productivity.**
2. **Provisions of this dive plan and the ADF&G Manual for Scientific Diving, Section 2.00, Diving Regulations for SCUBA (Open Circuit, Compressed Air) will be strictly adhered to.**
3. **At no time shall a dive team consist of less than two nor more than three divers.**
4. **Diving shall not occur at a distance greater than two miles from the support vessel nor more than 100 yards from the tending skiff.**
5. **In the event that the dive tender deems it necessary for the divers to ascend, the dive tender shall (a) ensure the tending skiff engine is in neutral and (b) rev the engine three times. This process shall be repeated until the divers have ascended to the surface and make visual and audible contact with the tender.**
6. **Whenever environmental conditions prevent the tender from tracking the divers' bubbles, the dive team should consider another dive location.**

7. **All diving shall be conducted with a dive computer. If tables are consulted, they will be the Navy No-Decompression Limits and Repetitive Group Designation for No-Decompression Air Dive, as displayed in the NOAA No-Decompression Air Dive Table. The dive table will be used for dive planning.**
8. **Following the completion of all dives, divers will continue to wear their masks and fins until they are aboard the skiff to enable the diver to self-assist in case of complications following the dive.**
9. **During and between dives, dive tenders shall maintain an active log that includes as a minimum: date, location (lat/long from portable GPS), divers' names, tender's name(s), start and end dive time, start and end tank pressure, notes about the work accomplished, and any problems encountered. Planned depth and dive time shall be recorded prior to the start of any dive. The tender shall be prepared to archive and replace field data forms as necessary.**
10. **Following the dives each day, debriefings shall be held among divers and affected personnel to discuss aspects of the day's work.**

Dive Equipment

Divers and dive tenders will perform rigorous dive partner equipment checks before every dive. Divers are equipped with a full complement of standard SCUBA equipment and inflatable shell dry suits. Buoyancy compensation devices (BC) are used for safety, to increase reserve buoyant capacity, and to provide redundancy in the buoyancy systems. The BC also enhances a diver's ability to surface in the event of catastrophic suit failure or entanglement with equipment, derelict fishing gear, or marine vegetation. Divers will carry sharp, serrated knives for self-rescue. Reserves of diving air, a first aid kit, and an oxygen kit are carried aboard the diver tender skiff to facilitate diver support if needed. Divers will work 3-5 pounds heavier than the standard "middle of forehead" criteria. Divers will visually monitor their partner's suit inflation and remain aware of the increase in potential problems created by a positive buoyancy situation in a ditched weight, free, or partial free ascent scenario. Diving air is obtained daily from the mother support vessel.

Dive Equipment Protocols

1. **Prior to the field project, the project dive master shall determine that dive compressor maintenance records and equipment service records are current and approved as per criteria specified in the ADF&G *Manual for Scientific Diving Safety*, Section 3.52.**
   a. **Compressor maintenance shall include oil changes every 35 hours or 200 dive tanks and filter cartridge changes every 20 hours or 120 dive tanks.**
   b. **The breathing air compressor will be tested for air quality standards specified in the ADF&G *Manual for Scientific Diving Safety*, at intervals not to exceed the lesser of either 100 hours of operation or 6 months, or when returned to service from storage.**
2. **All dive cylinders shall be current with regard to visual and hydrostatic inspections and shall be properly labeled and stamped accordingly.**

3. **Each diver in the dive team shall carry at least one easily accessible, sharp, serrated knife. Each diver tender will also have a sharp, serrated knife readily available.**
4. **Each diver in the dive team shall be equipped with a redundant second-stage regulator breathing source.**

Diving Safety Considerations

In addition to the usual dangers of underwater work, project diving is physically demanding. Interactions with marine mammals, specifically sea lions, also pose risks and distractions for the divers. Not all potential dive accidents are equally likely to occur. Specific combinations of dive depths, dive times, and work performed, including exertion levels, can lead to different injuries and illnesses. In general, dive work will be shallow enough that problems associated with deep-water dives, such as oxygen toxicity and nitrogen narcosis, are very unlikely. Decompression sickness, while possible, is also quite improbable for the dives provided that divers ensure to maintain well within no-decompressions limits, particularly through repetitive dives. The likelihood of ear squeezes, sinus squeezes, suit squeezes, pulmonary edema, and asphyxia is similar to any shallow-water diving project.

Appendix F assesses the likelihood of specific diving injuries or illnesses as a result of participation in this project

Dive Safety Protocols

1. **Divers shall conduct a 3-5 minute safety stop during ascent in the 15-25 fsw depth range on any dive greater than 60 fsw.**
2. **Ascent rates will not exceed 30 feet/min.**
3. **As a minimum, each tending skiff shall be equipped with a functional two-way marine VHF radio, emergency flare kit, an emergency oxygen kit, and a first aid kit.**
4. **The support vessel shall maintain a continuous radio watch while skiffs are at work away from the boat. This watch will enable long-range communications, first aid supplies, oxygen, additional dive tanks, other safety equipment, and reference materials to be readily available.**
5. **The dive tender shall notify the support vessel via radio whenever divers enter and exit the water.**
6. **This dive plan shall be available on the bridge of the support vessel when dive operations are underway.**
7. **Divers shall remain awake and associate with other persons for at least one hour after exiting the water. This will allow them to be monitored for signs of dive-related illness.**
8. **All vessel crew shall be currently certified in first aid/ CPR, and oxygen administration.**

Diving with Steller Sea Lions

The precise risk involved in diving with Steller sea lions is unknown; no formal studies have been done. Although a large body of anecdotal information indicates sea lions will readily approach divers, no formal studies have been conducted. Although sea lions may appear threatening and physical contact between divers and sea lions may occur, no overt aggression has been reported and interactions are typically short in duration. Even without serious aggression, such interactions may interfere with a diver's ability to continue diving in comfort. Because sea lions are reluctant to approach a diver on the surface, ascending should revolve any interaction problems as well as allow the dive team an opportunity to apprise the dive tender of the situation.

Sea Lion Management Protocols

1. **Either member of a dive team may terminate the dive if the diver feels threatened by any animal.**

Diving Accident Management

In the broad sense, diving accident management includes the suite of activities ranging from accident prevention to caring for an injured diver. This recognizes that the best way to deal with dive accidents is prevention. After an accident occurs, accident management is a critical element in safeguarding the stricken diver. Events occurring in the time between the accident and delivery to a medical facility can significantly impact on the diver's recovery. Permanent impairment may be prevented, and even the diver's life saved, depending on actions taken in the field before qualified physicians or paramedics become involved.

Accident Awareness

Pressure changes causing embolism are most acute in shallow water and asphyxia can occur in only inches of water. Remaining aware that diving accidents can occur even during easy dives and having a working knowledge of the types of likely accidents leads divers to safer diving practices. Knowing that asphyxia and embolism are potential hazards even during shallow dives should encourage divers to avoid situations in which their air supply might be disrupted and to practice good breathing habits while ascending. This knowledge also facilitates earlier recognition and better diagnosis of injuries. Awareness that decompression sickness is less likely during shallow water diving, but the likelihood of embolism is slightly enhanced enables better evaluation of symptoms.

Monitoring Divers

Monitoring divers for signs of injury and illness is often difficult. Persons hurt or sick will tend to withdraw from social interaction and will often seek relief in their bunks. Also, ego or concerns about letting their fellow divers down may cause divers to conceal or deny their problems. For those reasons, it is important for dive supervisors to monitor their divers closely, especially during the first hour after diving, and for divers to honestly evaluate their condition.

Accident Management Regimes

When a diving injury or illness is detected, it is important to assess the type of accident management required. All diving illnesses and injuries can be categorized as: (1) those treatable by the stricken diver alone; (2) those that require intervention of other field personnel; or (3)

those that require transport to a medical facility. Minor medical conditions that remain evident after diving such as suit squeezes and sinus congestion generally require only self-treatment by the diver. Mild decompression sickness, mild carbon monoxide poisoning and hypothermia generally require assistance for oxygen administration, warming the patient or other procedures. Serious decompression sickness, embolisms, near-drowning and pronounced carbon monoxide poisoning always require transport.

Emergency Assistance

Communications

In the event of a serious diving injury or illness, long distance communication is critical to obtaining medical advice and emergency evacuation of the patient. Due to this project's use of vessels, a satellite phone and a variety of reliable and easily used radio systems are generally available. Direct contact can almost always be established from anywhere along the Gulf of Alaska coast, but if needed, relays through other vessels may be arranged. The primary contact for remote vessel operations and for this dive work is the United States Coast Guard (USCG). In most cases, the USCG Communications Station – Kodiak can be reached on marine VHF channel 16 or single sideband frequency 4125.0 MHz. The USCG will respond with emergency medical consultation, transportation and other assistance as required. Once contacted, the USCG will periodically monitor the situation and generally make further arrangements. If the USCG is deemed not the appropriate rescue agency, perhaps because they are too far away or busy with another rescue, then contact can also be made with private medical consultants, commercial transportation companies, municipal emergency services, area hospitals, ADF&G dive officers and others as needed. Appendices 1 and 2 list telephone numbers and radio frequencies for a variety of emergency contacts.

Transportation

The degree to which the victim of a serious diving accident recovers and avoids permanent impairment is often directly related to the rapidity in which sophisticated professional treatment is obtained. Because this type of care is generally unavailable in the field, emergency transportation may be required.

In truly remote areas, the USCG should be the first contact as they are equipped and trained to respond to areas and in weather conditions where others cannot. In more traveled areas or when the work is being done close to a community with a well qualified medical facility, commercial air transportation or the use of the project's skiff or vessel may be more appropriate. To some degree, the stricken diver's condition will determine the urgency of travel. Generally, when travel to professional medical services exceeds two hours, the Coast Guard should be called.

Medical Consultation

When only medical consultation is required, perhaps for on-board treatment, and phone service is available, consultation can be obtained from the Northwest Diving Network in Seattle or from the Diving Accident Network (DAN) at Duke University. DAN consultations are available 24 hours a day. These services will not make diagnoses or practice medicine over the phone, but can provide detailed diving illness and injury information.

Hyperbaric Chambers
The closest permanent hyperbaric chambers are available at American Hyperbaric Center in Anchorage, Providence Hospital in Anchorage, Bartlett Memorial Hospital in Juneau, and Virginia Mason Medical Center in Seattle (see Emergency Contacts). Other portable units may be available in the project's vicinity and it may be advisable to assess their location prior to project fieldwork in case of an extreme emergency. Two commercial diving companies that carry portable units to their job sites are American Divers out of Anchorage and Alaska Diving Services out of Ketchikan. **The availability and types of hyperbaric chambers shall be verified immediately prior to each field project.**

Area Hospitals Without Hyperbaric Chambers
Additional major area hospitals are in Homer, Cordova, Soldotna, Ketchikan, Kodiak, Petersburg, Seward and Sitka.

EMERGENCY PROTOCOLS

Contact information for emergency transportation and consultation is provided in the section EMERGENCY CONTACTS. Appendix G provides an Accident Flow Diagram to simplify the decision making process for determining the most appropriate management regime and selecting appropriate treatments. Appendix H provides signs and symptoms of selected dive illnesses and Appendix I provides First Aid procedures for selected dive illnesses.

1. **Refer to Appendix G, Dive Accident Flow Diagram.**

2. **As soon as possible, all diving injuries and illnesses shall be categorized as on of the following to facilitate further accident management decisions:**
   a. **Regime I - Treatable by the diver only;**
   b. **Regime II - Treatable on-board with the assistance of other personnel; or**
   c. **Regime III - Requiring emergency transportation to a medical facility.**

3. **Stricken divers with suspected asphyxia, embolism, type II or type III decompression sickness or serious carbon monoxide poisoning shall be transported to an appropriate medical facility.**

4. **A stricken diver's equipment including his air supply shall be secured for later inspection if there is any reason to suspect it contributed to the accident. The tank pressure upon exiting the water, the position of the tank valve, and the amount of weight the diver carried shall be noted.**

5. **The diver's tank and regulator set shall be transported with the stricken diver if there is any reason to suspect this equipment contributed to the accident.**

6. **A stricken diver's recent dive history shall be recorded and accompany the diver upon evacuation; completion of the appendix ACCIDENT OR INCIDENT REPORTING FORM will facilitate this process.**

7. **The stricken divers buddy shall also accompany the diver if there is any reason to suspect he might suffer from a like affliction or be of diagnostic assistance.**

8. **For each stricken diver transported, the following emergency contact shall be notified unless the diver denies permission**

Diver	Contact	Telephone - Day	Telephone - Hm	Address
William Bechtol	**Eileen Bechtol**	**(907)235-4246**	**(907)235-6713**	**Homer, AK**
Mike Byerly	**Doreen Byerly**	**(336)299-6135**	**(336)299-6135**	**Greensboro, NC**
Carl Schoch	**Nancy Bird**	**(907)424-5800**	**(907)299-1332**	**Cordova, AK**
Jake Glotfelty	**Jim Hansen**	**(907)243-1826**	**(907)243-1826**	**Anchorage, AK**
Margaret Spahn	**Don Markowitz**	**(907)399-8184**	**(907)262-6739**	**Soldotna, AK**

EMERGENCY CONTACTS

EMERGENCY TRANSPORTATION:

Marine VHF channel 16, United States Coast Guard (USCG)
Single side band 2182 and 4125 (Kodiak), USCG
800-478-5555, USCG general emergency contact number
907-463-2000, USCG command center Juneau
907-487-5888, USCG command center Kodiak
907-271-6700, USCG Anchorage
907-261-3070, Lifeguard Air Ambulance, Learjet, Anchorage (to Seattle)
907-586-2611, Bartlett Memorial Hospital transport, Citation, Juneau (to Seattle)
800-426-0333, Alaska Airlines, general reservation number
907/235-8256, Beluga Lake Float Plane Service, Homer
907/235-7482; Northwind Aviation, Homer

HYPERBARIC CHAMBERS:

907/565-4600, American Hyperbaric Center., Anchorage, 7day/24hr
if no answer – contact 907/244-9928, Jim Thompson
907-586-2611, Bartlett Memorial Hospital, Juneau
206-583-6433, Virginia Mason Medical Center, Seattle 8 am $\Rightarrow$ 5:30 p.m.
206/583-6453 on weekends and after 5:30 p.m.
907-561-3111, **ER** Providence Hospital, Anchorage they consult Am. Mar. Corp. (above)
907-225-3667, Alaska Diving Services, Ketchikan

AREA HOSPITALS (without hyperbaric chambers):

907-235-8101, Homer
907-424-8000, Cordova
907-225-5171, Ketchikan
907-486-3281, Kodiak
907-772-4291, Petersburg
907-224-5205, Seward
907-747-3241, Sitka

MEDICAL CONSULTATION:

919-684-8111 or 1-919-684-4DAN (***collect***) DAN
919-684-2948 DAN ***Non-Emergency Medical Questions***
206-624-1144, Northwest Diving Network, Seattle

STATE TROOPERS:

907-235-8239, Homer
907-486-4121, Kodiak
907-224-3346, Seward
907-262-4453, Soldotna
907-428-7200, Anchorage
907-465-4000, Juneau
907-225-5188, Ketchikan
907-747-6611, Sitka
907-772-3100, Petersburg

ADF&G DIVE OFFICERS:

907-772-5237, 907-465-4228(W), Kyle Hebert, Dept. Dive Officer, Juneau
907-465-4244, 907-789-7105(H), Marc Pritchett, Dive Board member, Juneau
907-465-4268, 907-789-3598(H), Dave Barto, Dive Board member, Juneau

PROJECT PERSONNEL

The following identifies the principal personnel involved with the Department's rockfish research program diving activities. Support personnel and specific divers may vary between survey legs based on availability.

DIVE TEAM LEADER: William Bechtol is the Research Project Leader and serves as the ADF&G Local Dive Safety Officer.

PRINCIPAL INVESTIGATOR: Michael Byerly is based in Homer and serves as the principal investigator for the Department's nearshore rockfish research project.

Dive Team:

The dive team for this Department rockfish research program consists of:

- William Bechtol resides in Homer as the ADF&G Commercial Fisheries Research Project Leader for groundfish/shellfish; PADI Advanced Open Water, PADI Rescue Diver, NAUI Master Diver, NOAA Working Diver, and NOAA Divemaster, and Nitrox and Visual Cylinder Inspection certifications; ADF&G Scientific Diver certified to 100 fsw. Through April 2004, has over 580 logged dives totaling 288 hrs.
- Michael Byerly resides in Homer as the project principal investigator; PADI Open Water, PADI Rescue Diver, NAUI Master Diver, NOAA Working Diver, and Nitrox certifications. ADF&G Scientific Diver certified to 100 fsw. Through April 2003 has over 215 logged dives totaling 110 hrs.
- Carl Schoch resides in Homer, but works in Cordova, as the Science Director for the Prince William Sound Science Center. Certifications include DIT commercial, NAUI Master Diver, OSU Science Diver, NOAA Working Diver; NOAA Divemaster, ADF&G Scientific Diver certified to 120 fsw, and has Nitrox and Visual Cylinder Inspection certifications. Through April 2004 has 942 logged dives totaling over 1070 hrs.
- Jake Glotfelty resides in Kenai as a Fish and Wildlife Technician III. Certifications include PADI Advanced Open Water, NAUI Master Diver, NOAA Working Diver. ADF&G Scientific Diver certified to 60 fsw. Through April 2004 has over 50 logged dives totaling 21 hrs.
- Margaret Spahn, resides in Homer, as a Fishery Biologist I. Certifications include NASDS Open Water and PADI Open Water. ADF&G Diver-in-Training certified to 30 fsw. Through May 2004 has 10 logged dives totaling 4 hrs.

Dive Tenders

Dive tenders for this project include Margaret Spahn and the research vessel *Pandalus* crew, skipper Mark Hottmann and boat engineer Del Masterhan. In addition, divers will serve as tenders on rotational basis.

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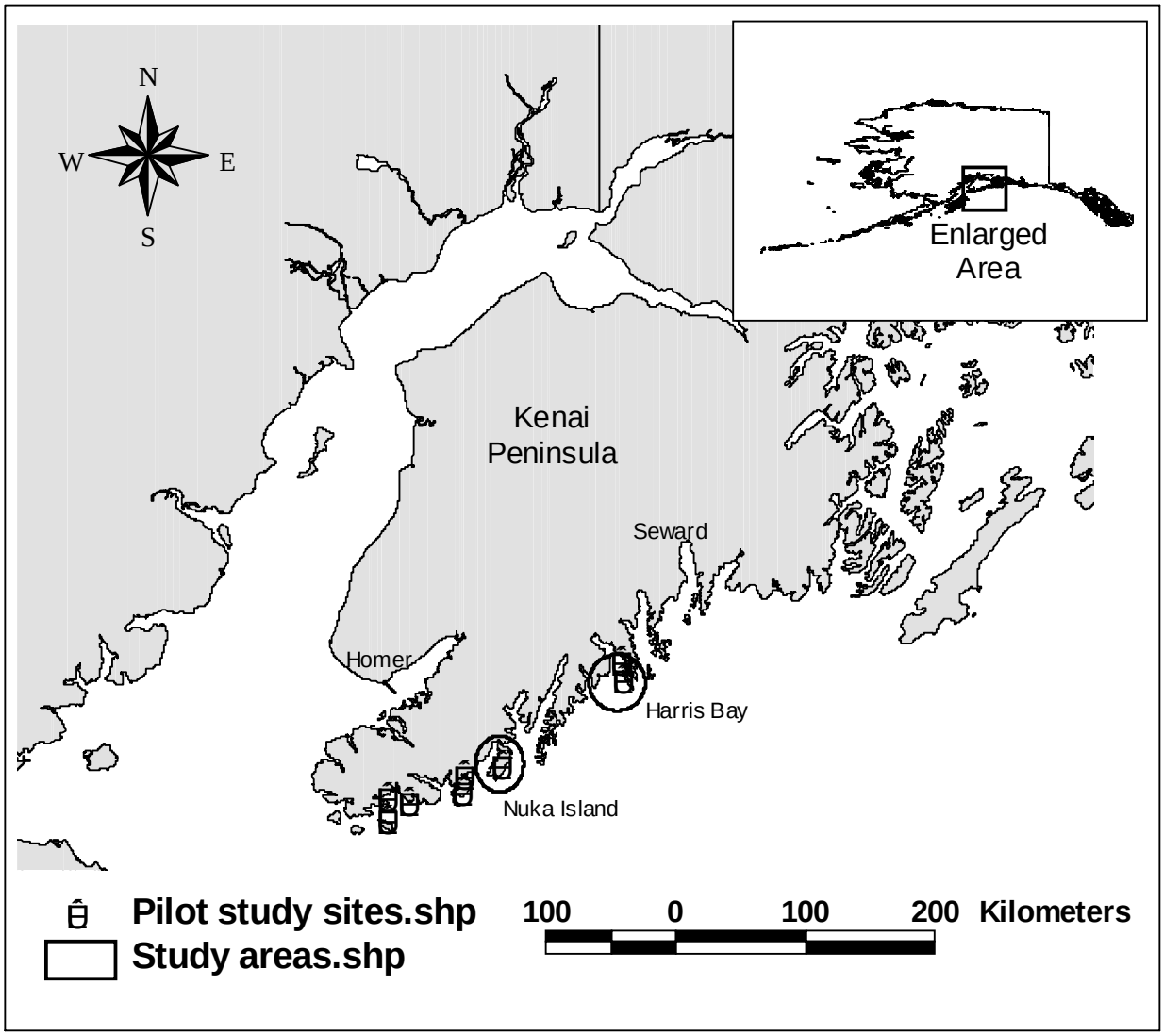


Figure 1. Study sites for previous nearshore rockfish assessment surveys, 2002-2003.

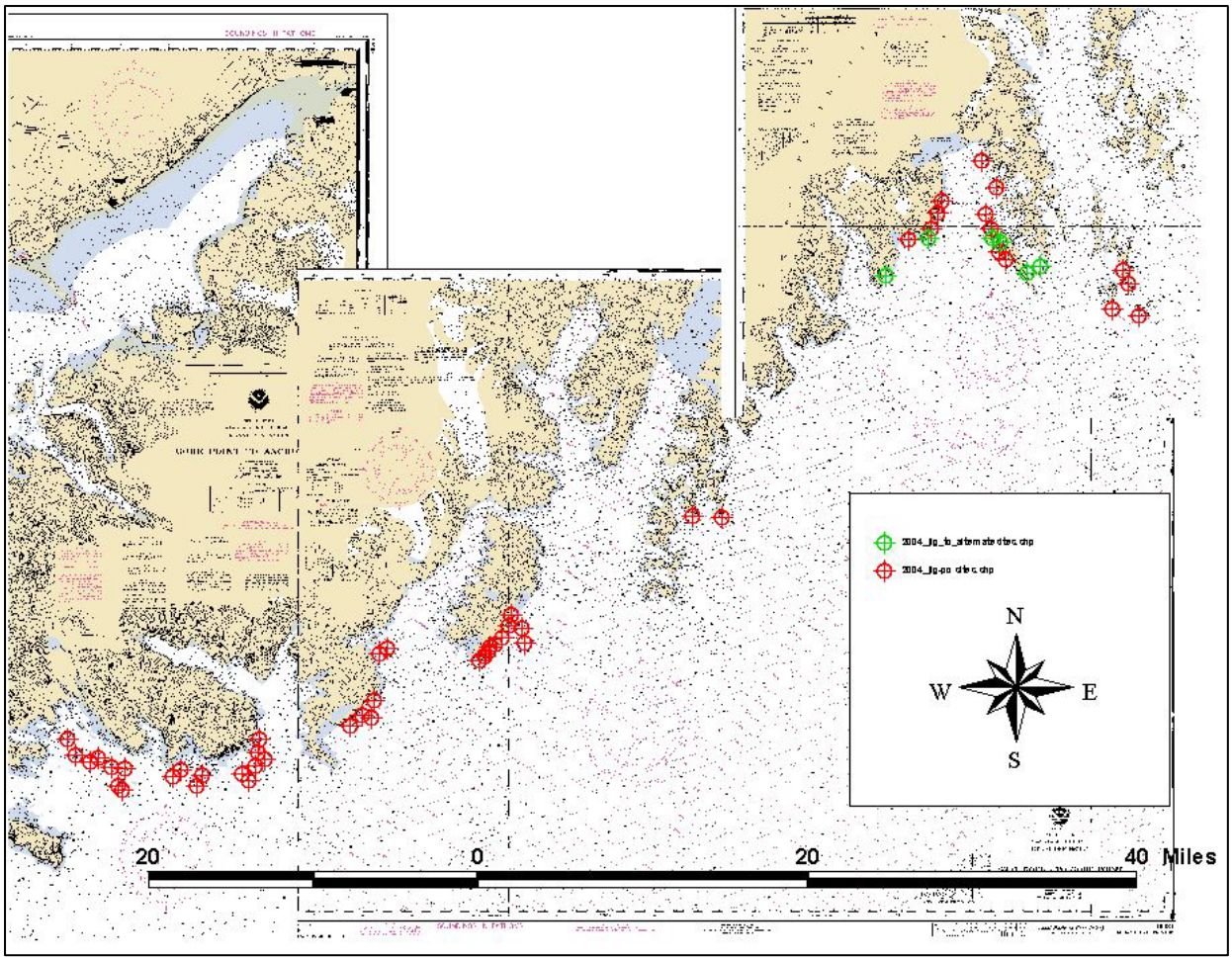


Figure 2. Sites for jig and dive indices study, 2004.

Appendix A. Daily event sequence of events for the dive teams and jig boat, 2004.

1) The jig boat will visit the first site, locate the appropriate depths (5 to 11 fa) and determine the predominate drift. The crew will mark the start and end points with anchored buoys.

2) The jig boat will move to the next site and repeat the preceding procedure.

3) A dive skiff will be on site ready to dive after the jig boat has marked each site. The dive team will perform three replicate timed counts.

4) After the first dive team is finished, the jig boat will return to the site, jig for 30 min. and proceed to the next site to jig.

5) Following the first dive, the dive team will return to the Pandalus to switch out tanks and off gas until the appropriate group letter is reached.

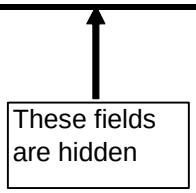
6) After the jig boat is finished jigging the second site, it will proceed to the third and forth sites to mark the start and end points.

7) After the appropriate surface interval is reached, the dive teams will proceed to the third and forth sites to repeat the procedure.

8) The preceding sequence will repeat its self until eight sites are sampled for the day.

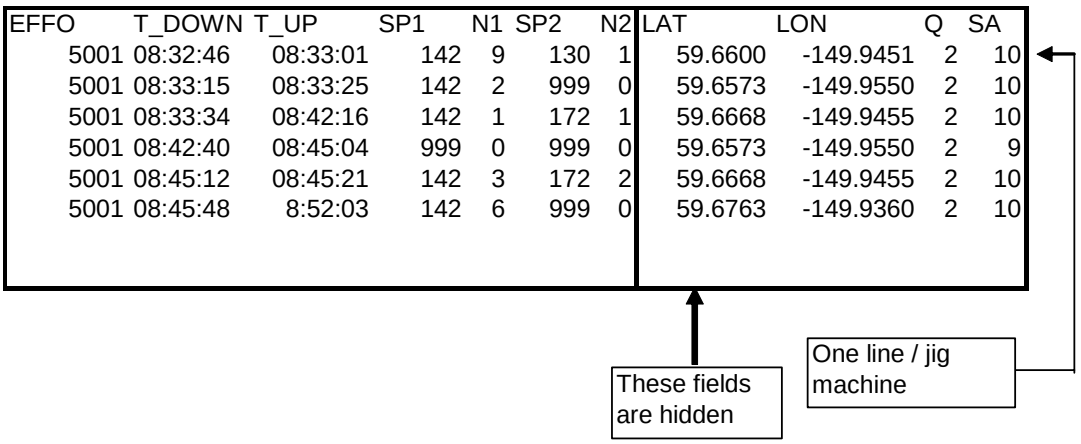
Appendix B. Example of TCCOUNT data entry screen.

EFFO	REP	DATE	TIME	SI	WD	SP	SEA	LAT	LON	Q	SA
4501	1	05/21/04	12:12:57	1	NW	10	2	59.6600	-149.9451	2	10
4501	2	05/21/04	12:25:28	1	NW	10	2	59.6573	-149.9550	2	10
4501	3	05/21/04	12:40:28	1	NW	10	2	59.6668	-149.9455	2	10
4502	1	05/21/04	15:12:57	1	NW	5	1	59.6573	-149.9550	2	9
4502	2	05/21/04	15:25:28	1	NW	5	1	59.6668	-149.9455	2	10
4502	3	05/21/04	15:40:28	1	NW	5	1	59.6763	-149.9360	2	10



Field	Description	Comments	
EFFO	Effort number	One effort number / site	
REP	Replicate	Three reps / site	
DATE	Date		
TIME	Time	Time divers decend; Press ctrl T to update time	
SI	Site		
WD	Wind Direction		
SP	Wind Speed		
SEA	Wave Height	Two digit field. Once you press enter, you should hear 4 beeps and then a new line should appear with most of the fields copied	
LAT	Latitude	Will log automatically	GPS data recorded at position where divers decend
LON	Longitude	Will log automatically	
Q	Differential corrections	Will log automatically	
SA	Number of Satellites	Will log automatically	

Appendix C. Example of RFCPUE data entry screen, 2004.



Field	Description	Comments	
EFFO	Effort number	One effort number / site	
T_DOWN	Time down	Will log automatically; Press ctrl T if you need to update time	
T_UP	Time up	Press ctrl T to update time	
SP1	Species one		
N1	Number caught		
SP2	Species two		
N2	Number caught	One digit field. Once you enter a number, you should hear 4 beeps and then a new line should appear with most of the fields copied	
LAT	Latitude	Will log automatically	GPS data recorded at position where divers decend
LON	Longitude	Will log automatically	
Q	Differential corrections	Will log automatically	
SA	Number of Satellites	Will log automatically	

Appendix D. Substrate codes.

Code	Expanded Name	Definition
BAS	Basement	Solid Bedrock
BLK	Block	Rocks > 3 m dia.
LBO	Large Boulder	Rocks >1 – 3 m dia.
SBO	Small Boulder	Rocks >10” (256 mm) dia. – 1 m.
COB	Cobble	Rocks 2½”” (64 mm) – 10” (256 mm) dia.
GRV	Gravel	Small rocks or pebbles ¼” (4 mm) – 2½” (64 mm) dia
SND	Sand	Clearly-separate grains < ¼” (4 mm) dia
MUD	Mud	Soft, past-like material
SIL	Silt	Fine organic dust (rarely used)
SHE	Shell Hash	Area primarily covered with whole or crushed shells

Appendix E. Fish species grouping codes.

Group	Code	Expanded Code	Latin name
Rockfishes	RB	Redbanded	*S.babcocki*
	SG	Silvergray	*S.brevispinis*
	CO	Copper	*S.caurinus*
	DU	Dusky	*S.ciliatus*
	YT	Yellowtail	*S.flavidus*
	QB	Quillback	*S.maliger*
	BK	Black	*S.melanops*
	CH	China	*S.nebulosus*
	TI	Tiger	*S.nigrocinctus*
	YE	Yelloweye	*S.ruberrimus*
	UR	Unknown Rockfish	*Unknown Sebastes*
	JB	Juvenile Black	*Juvenile S. melonops*
	JCQ	Juvenile Copper/Quillback	*Juv. S. caurinus / maliger*
	JD	Juvenile Dusky	*Junenile S. ciliatus*
Greenlings	GL	Greenling	*Hexagrammidae*
	KG	Kelp Greenling	*H. decagrammus*
	RG	Rock greenling	*H. lagocephalus*
	JG	Juvenlile greenling	*Juvenile Hexagrammidae*
	LC	Ling Cod	*Ophiodon elongatus*
Other	SU	Sculpin	*Cottidae*
	JC	Juvenile gadid (cod)	*Juvenile Gadidae*
	PB	Prickleback	*Stichaeidae*
	TS	Tubesnout	*Aulorhynchidae*
	SF	Salmon fry	*Salmonidae*
	SL	Sandlance	*Ammodytidae*
	CS	Coho	*S. kisutch*

Appendix F. Specific field project details.

DATES: June 4-12, 2004

LOCATION:
Southcentral, Alaska. Outer Kenai Peninsula.

VESSEL: R/V *Pandalus* **VHF CALL SIGN:** WAV 7611
HOME PORT: Homer, Alaska **VESSEL CAPTAIN:** Mark Hottmann
VESSEL: F/V Arctic Flyer **VHF CALL SIGN:** WCZ 9901
HOME PORT: Homer, Alaska **VESSEL CAPTAIN:** Matt Stover
PROJECT LEADER: Mike Byerly **DIVE MASTER:** William Bechtol

DIVER: William Bechtol, ADF&G
EMERGENCY CONTACT: Eileen Bechtol, 907-235-6713, Homer, AK
DIVER: Michael Byerly, ADF&G
EMERGENCY CONTACT: Dorean Byerly, 336-299-6135, Greensboro, NC
DIVER: Margaret Spahn, ADF&G
EMERGENCY CONTACT: Don Markowitz, 907-262-6739, Soldotna, AK
DIVER: Jake Glotfelty, ADF&G
EMERGENCY CONTACT: Jim Hansen, 907-243-1826, Anchorage, AK
DIVER: Carl Schoch, PWSSC
EMERGENCY CONTACT: Nancy Bird, 907-424-5800, Cordova, AK

DIVE TENDER: Margaret Spahn **DIVE TENDER**: Del Masterhan
DIVE TENDER: Mark Hottmann **DIVE TENDER**:

MEDICAL PERSONNEL: None

NUMBER OF DIVES: 120	**DEPTH:** 70 ft	**DURATION:** 10 mins.	**FOR:** fish enumeration
NUMBER OF DIVES: 10	**DEPTH:** 60 ft	**DURATION:** 30 mins.	**FOR:** proficiency training

SUPPORT EQUIPMENT: Vessel, 18' and 20' Skiff, Oxygen

SPECIAL HAZARDS: Currents.

NEAREST HYPERBARIC CHAMBER: American Hyperbaric Center.(multichamber unit)
ADDRESS: Anchorage, AK **PHONE:** 907/565-4600, 7day/24hr
907/244-9928 (alternate ph#)

NEAREST HYPERBARIC CHAMBER: American Hyperbaric Center (multichamber unit)
ADDRESS: Wasilla, AK **PHONE:** 907-357-5400

NEAREST HYPERBARIC CHAMBER: Alaska Regional Hospital (Compresses to 66 ft)
ADDRESS: Anchorage, AK **PHONE:** 907-264-1222

HYPERBARIC CHAMBER: Bartlett Memorial Hospital (multichamber unit)
ADDRESS: Juneau, AK **PHONE:** 907-586-2611

HYPERBARIC CHAMBER: Virginia Mason Medical Center (*full time on line)*
ADDRESS: Seattle WA **PHONE:** 206-583-6433, weekend & after 5pm
206-583-6453, 8 to 5pm

NEAREST MEDICAL FACILITY: South Peninsula Hospital
ADDRESS: 34300 Bartlett St., Homer, AK **PHONE:** 907-235-8101

MEDICAL CONSULTATION: Northwest Diving Network, Seattle **PHONE:** 206-624-1144
MEDICAL CONSULTATION: Divers Alert Network, Durham, NC **PHONE:** 919-684-4326
MEDICAL CONSULTATION: Providence Medical Center, Anchorage **PHONE:** 907-261-3111 (**ER**)
MEDICAL CONSULTATION: Alaska Regional Hospital, Anchorage **PHONE:** 907-264-1222 (**ER**)

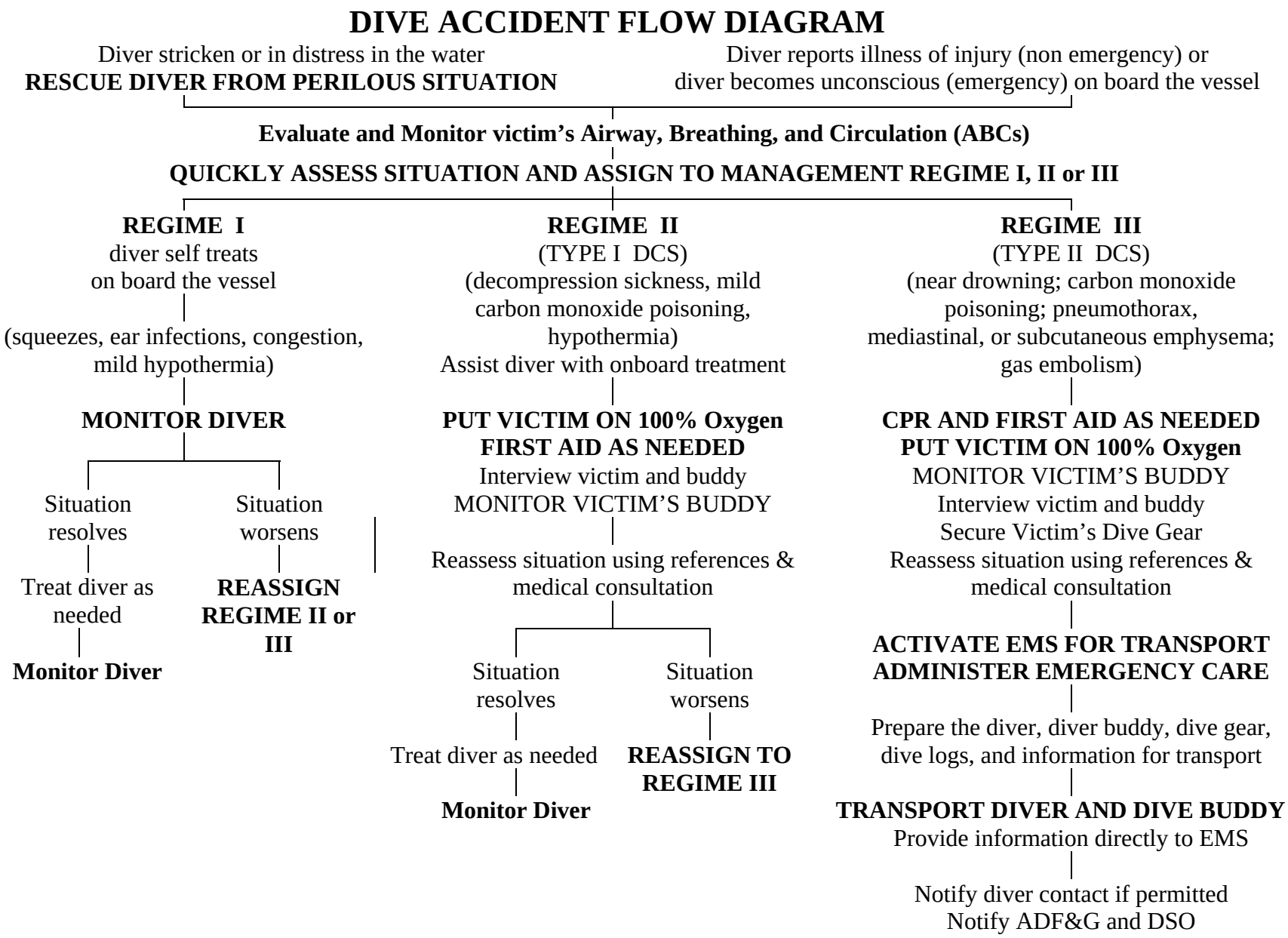
EMERGENCY TRANSPORTATION: US Coast Guard **PHONE:** 800-478-5555
EMERGENCY TRANSPORTATION: EMS **PHONE:** 911
ADF&G DIVE BOARD CONTACT: Kyle Hebert, Juneau **PHONE:** 907-465-4228 W

Appendix G. Assessment of specific dive accident likelihood

(A Diagnostic Aid For Accident Management: Assumes no more than 2 dives per day to an average maximum depth of 60 feet with a cumulative bottom time and sufficient surface intervals to achieve a Repetitive Group Designation no greater than "I" on the Navy tables. Also assumes using trained and practiced working divers).

DIVE INJURY OR ILLNESS	CAUSE OR CONTRIBUTING FACTOR	LIKELIHOOD WHILE ASSESSING ROCKFISH
High pressure nervous syndrome	Diving to depths in excess of 300 ft	Virtually impossible
Pulmonary oxygen toxicity	Breathing oxygen at high partial pressures (great depth over long duration)	Virtually impossible
Central nervous system (CNS) oxygen toxicity	Breathing oxygen at high partial pressures (great depth over long duration)	Virtually impossible
Inert gas narcosis (nitrogen)	Diving on air to depths generally greater that 100 ft	Virtually impossible
Thoracic squeeze	Breath-holding while descending	Possible, but very unlikely using SCUBA
Type II decompression sickness (CNS)	Exceeding the no-decompression limits without adequate stops	Possible, but very unlikely
Type I decompression sickness (pain only)	Exceeding the no-decompression limits without adequate stops	Possible, but unlikely
Carbon dioxide poisoning	Poor breathing practices (skip breathing)	Possible, but unlikely
Carbon monoxide poisoning	Breathing air contaminated with carbon monoxide	Possible, but unlikely with good compressor maintenance
Barotrauma (ear and sinus)	Failure to equalize properly	Average likelihood
Round window rupture	Improper equalization method	Average likelihood
Suit squeeze	Failure to add adequate air	Average likelihood
Mask squeeze	Failure to add adequate air	Average likelihood
Otitis externia (swimmers ear)	Altered Ph balance resulting in infection	Average likelihood
Pneumothorax	Lung over pressurization upon ascent (breath-holding or bronchial blockage)	Average likelihood
Mediasternal emphysema	Lung over pressurization upon ascent (breath-holding or bronchial blockage)	Average likelihood
Subcutaneous emphysema	Lung over pressurization upon ascent (breath-holding or bronchial blockage)	Average likelihood
Air embolism	Lung over pressurization upon ascent (breath-holding or bronchial blockage)	Average likelihood
Asphyxia (near drowning)	Loss of breathing air while diving (running out of air or loss of regulator)	Average likelihood

Appendix H. Dive Accident Flow Diagram.



Appendix I. Selected dive illness signs and symptoms.

This table is intended to be a handy reference to aid in identifying dive illnesses that both might occur during rockfish assessment and are of a serious nature. These are conditions that generally require timely attention and evacuation to a medical facility. Types I and II decompression sickness, pneumothorax, mediastinal emphysema, subcutaneous emphysema, gas embolism and asphyxia are included. Type I decompression sickness probably would not require evacuation, but it is included in order to distinguish type II. And asphyxia is quite self-evident, but it is a serious dive illness that might also involve other significant problems. Less serious dive illnesses such as sinus squeeze and ear infection generally do not require rapid attention nor evacuation and their diagnosis and treatment are adequately detailed in other reference materials.

DECOMPRESSION SICKNESS TYPE I (DCS-I): Nitrogen bubbles in tissues
- Usually require some time, maybe several hours (not over 48) to develop
- Deep, dull, localized, non-radiating pain in extremities (torso pain is DCS-II)
- Itchy skin
- Faint skin rashes (mottling or marbling is DCS-II)
- Slight tenderness of lymph nodes

DECOMPRESSION SICKNESS TYPE II (DCS-II): Nitrogen bubbles in tissues
- Severe cases develop within minutes of surfacing
- DCS-I symptoms may be present
- Moderate, radiating joint or torso pain
- Mottled or marbleized skin
- Painful, swollen lymph nodes
- Numbness, tingling and decreased sensation to touch
- Vertigo, dizziness and ringing in the ears
- Abnormal fatigue and weakness
- Difficulty walking, hearing or urinating
- Amnesia, uncoordination, tremors and unusual behavior
- Chest pain, lung congestion, cough and rapid respirations
- Loss of consciousness……..death

PNEUMOTHORAX: Air in chest from ruptured lung
- Sharp pain in chest, shoulder or upper back aggravated by deep breathing
- Difficulty in breathing (shortness of breath)
- Shallow, rapid breathing
- Bending chest toward affected side
- General pallor (blue skin, lips and nails)

TENSION PNEUMOTHORAX: Accumulating air in chest from ruptured lung
- All of above pneumothorax symptoms
- Accumulating pressure in chest
- Collapsed lung
- Pressure on heart
- Faintness

MEDIASTINAL EMPHYSEMA: Air in space between lungs from ruptured lung
- Dull, mild to moderate pain or tightness behind breast bone
- Difficulty in breathing (shortness of breath)
- Sometimes radiating pain to shoulder, neck or back
- Change of voice

Selected Dive Illness Signs and Symptoms (Continued)

SUBCUTANEOUS EMPHYSEMA: Air from mediastinum under skin of neck and face
- Feeling of fullness around neck
- Difficulty swallowing
- Voice change
- Inflated pouches under skin
- Moving inflated skin produces crackling sound

ARTERIAL GAS EMBOLISM: Gas bubble obstruction of vessel from DCS or lung rupture
- Symptoms almost always immediately upon surfacing
- Dramatic, rapid onset (severe DCS takes at least a few minutes to develop)
- Sensation of sudden thump in chest while surfacing
- Dizziness or blurred vision
- Large areas of numbness, prickling, weakness or paralysis
- Loss of consciousness
- Stoppage of breathing
- Death

ASPHYXIA (NEAR-DROWNING): Water blockage of breathing air
- Unconscious diver in the water

FACTORS TO REMEMBER:
- Remember to consider the dive scenario and factor in the probability for any particular dive illness (APPENDIX 2) page 15, in searching for a diagnosis.
- Remember that more than one dive illness may be present in a given case.
- Remember that DCS II can cause an arterial gas embolism, but not vice versa.
- Remember that any rupture of lung tissue can lead to pneumothorax, mediastinal emphysema, subcutaneous emphysema, arterial gas embolism or any combination of these.
- Remember that any diver that surfaces unconscious may have drowned, suffered an arterial gas embolism or both.

Appendix J. Selected First Aid Procedures for Dive Illnesses.

Some Dos and Don'ts

(The following discussions are intended to provide a quick reference for some commonly asked diver first aid questions.)

HEIMLICH MANEUVER: The Heimlich maneuver, which is familiar to first aid providers for relieving choking, has now been demonstrated to be useful as a quick first response in near-drowning (where the victim is not breathing). It takes very little time to administer and it is often quite effective in expelling water from the trachea and possibly the lungs. In a large percentage of cases it also stimulates the person to breath, thus cardiopulmonary resuscitation (CPR.) is not needed. It is a safe procedure which when successfully employed can reduce the rescuer's and victim's exposure to disease transmission and lung damage that sometimes result from CPR. The Heimlich maneuver can even be done fairly easily in the water and may save precious time in reviving the victim before they can be removed to a boat or the land. **Every diver's buddy or tender should attempt** the Heimlich maneuver at the **earliest possible moment** in the event of any **near-drowning**.

OXYGEN ADMINISTRATION: Oxygen administration is perhaps the most important first-aid procedure in treating any moderate to serious dive illness including near-drowning, decompression sickness, gas embolism, contaminated air poisoning and other sicknesses. Providing 100% oxygen improves tissue oxygenation when it has been compromised. Elevated levels of oxygen in the tissues reestablishes normal metabolic function, eases breathing, reduces swelling and produces a calming effect. A higher partial pressure of oxygen in the tissues also speeds the removal of nitrogen and other gasses associated with decompression sickness and gas embolism. Oxygen can be given for up to several hours although short breaks, perhaps 10 minutes out of every hour, should be taken. **Always give 100% oxygen for dive illnesses**.

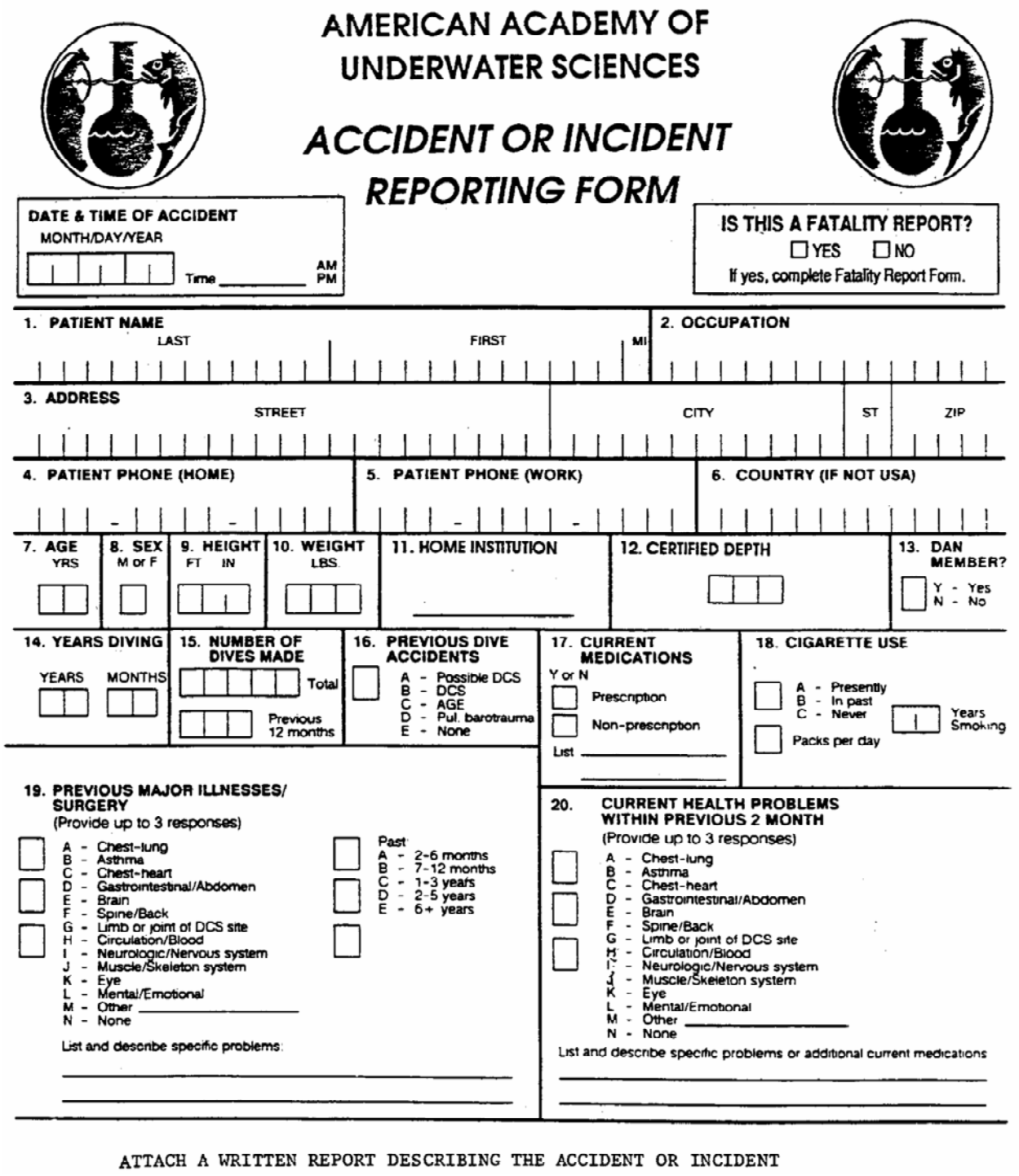
TRENDELENBERG POSITION: The Trendelenberg position in which a stricken individual is placed laying on a steep incline on the person's left side with the head down is a procedure historically prescribed but **NOT RECOMMENDED** today for the treatment of gas embolisms and decompression sickness. The supposed benefit of preventing gas bubbles from reaching the person's brain is now very much in doubt and the position may have serious side effects. It can lead to discomfort, restriction of the airway, cerebral edema and further embolization. The position is also very difficult to maintain on a moving boat or aircraft and may interfere with cardiopulmonary resuscitation, oxygen administration or other procedures. Instead, the stricken diver should be placed on a level surface on the back or side as needed and with the feet only slightly elevated if shock is suspected. **Do not use the Trendelenberg Position**.

REHYDRATION WITH FLUIDS: Unless a diving illness victim is unconscious or otherwise impaired, giving fluids, especially water and electrolyte balanced sports drinks, may be beneficial and should not cause harm. There is evidence to suggest that orally ingested fluids replenish intravascular volume, reverse hemoconcentration, raise blood pressure and increase microcirculatory flow. There is further indirect indication that this may hasten the elimination of excess inert gasses in cases of decompression illness and gas embolism***. If the stricken diver can tolerate fluids, give them***.

GIVING DRUGS: Although it is tempting to give aspirin or other mild pain relievers for the aches and pains of decompression illness, it is generally thought not to be wise to do so. There may be some slight beneficial effect of anticoagulants in reducing platelet deposition (clotting) around bubbles, but this is very minor relative to the important loss of the diver medic's most telling indicator of decompression sickness; pain. If the natural progression of the condition is to be adequately monitored either aboard the vessel or in the recompression chamber, the pain symptom must not be masked. ***Do not give pain relievers for dive illnesses***.

IN-THE-WATER RECOMPRESSION TREATMENTS: It is tempting with moderate cases of decompression sickness to place the stricken diver back in the water at some shallow depth. In theory this is sound and, in fact, it has been done successfully on a routine basis in some situations. To be practical, however, in-the-water recompression requires exceedingly close monitoring and specialized equipment. Generally surface supplied oxygen, intercoms and temperature controlled suits are needed. When attempting this procedure using SCUBA, it is fraught with dangers including the inability to follow an appropriate treatment schedule, hypothermia, drowning and the possibility of other dive accidents. ***In-the-water recompression treatments should not be attempted unless specifically trained and equipped to do so.***

Appendix K. Incident Reporting Form.



AMERICAN ACADEMY OF UNDERWATER SCIENCES

ACCIDENT OR INCIDENT REPORTING FORM

DATE & TIME OF ACCIDENT
MONTH/DAY/YEAR
Time _____ AM PM

IS THIS A FATALITY REPORT?
☐ YES ☐ NO
If yes, complete Fatality Report Form.

1. PATIENT NAME LAST FIRST MI

2. OCCUPATION

3. ADDRESS STREET CITY ST ZIP

4. PATIENT PHONE (HOME) - -

5. PATIENT PHONE (WORK) - -

6. COUNTRY (IF NOT USA)

7. AGE YRS

8. SEX M or F

9. HEIGHT FT IN

10. WEIGHT LBS

11. HOME INSTITUTION

12. CERTIFIED DEPTH

13. DAN MEMBER?
Y - Yes
N - No

14. YEARS DIVING
YEARS MONTHS

15. NUMBER OF DIVES MADE
Total
Previous 12 months

16. PREVIOUS DIVE ACCIDENTS
A - Possible DCS
B - DCS
C - AGE
D - Pul. barotrauma
E - None

17. CURRENT MEDICATIONS
Y or N
Prescription
Non-prescription
List _____

18. CIGARETTE USE
A - Presently
B - In past
C - Never
Years Smoking
Packs per day

19. PREVIOUS MAJOR ILLNESSES/ SURGERY
(Provide up to 3 responses)
A - Chest-lung
B - Asthma
C - Chest-heart
D - Gastrointestinal/Abdomen
E - Brain
F - Spine/Back
G - Limb or joint of DCS site
H - Circulation/Blood
I - Neurologic/Nervous system
J - Muscle/Skeleton system
K - Eye
L - Mental/Emotional
M - Other _____
N - None

Past
A - 2-6 months
B - 7-12 months
C - 1-3 years
D - 2-5 years
E - 6+ years

List and describe specific problems:

20. CURRENT HEALTH PROBLEMS WITHIN PREVIOUS 2 MONTH
(Provide up to 3 responses)
A - Chest-lung
B - Asthma
C - Chest-heart
D - Gastrointestinal/Abdomen
E - Brain
F - Spine/Back
G - Limb or joint of DCS site
H - Circulation/Blood
I - Neurologic/Nervous system
J - Muscle/Skeleton system
K - Eye
L - Mental/Emotional
M - Other _____
N - None

List and describe specific problems or additional current medications

ATTACH A WRITTEN REPORT DESCRIBING THE ACCIDENT OR INCIDENT

Incident Reporting Form (p. 2 of 4)

DIVE ACCIDENT OR INCIDENT

21. DIVE PLATFORM
- A - Shore
- B - Small boat
- C - Research Vessel

22. DIVE ACTIVITY (up to 2 responses)
- A - Collecting
- B - Photography
- C - Installing Equip.
- D - Servicing Equip.
- E - Observing
- F - Under instruction
- G - Providing instruction
- H - Other_____

23. ENVIRONMENT
- A - Freshwater
- B - Saltwater

24. ALTITUDE OF DIVE
- A - Sea Level
- B - > Sea Level but < 1000 ft
- C - > 1000 ft

25. Was this dive or dive series typical of your normal type of diving?
- Y - Yes
- N - No

IF NO, Explain_____

26. DIVER'S PERCEPTION OF TEMPERATURE
- A - Cold
- B - Hot
- C - Comfortable

27. CURRENT STRENGTH
- A - Strong
- B - Moderate
- C - Mild
- D - None

28. AIR SUPPLY
- A - Scuba Air
- B - Surface Supply Air
- C - Mixed gas
- D - None/Breath-hold dive

29. AIR CONSUMPTION
- A - Ran low
- B - Out of air
- C - Not a problem
- D - Buddy breathing (not octopus)

30. BUOYANCY PROBLEM
- Y - Yes
- N - No

31. RAPID ASCENT
- Y - Yes
- N - No

32. WITHIN LIMITS-Y or N
- Tables (which table_____)
- or
- Computer (type_____)

33. TYPE OF SUIT
- A - Wet
- B - Partial Wet
- C - Dry
- D - Lycra
- E - Swim

34. EQUIPMENT USED ON DIVE: (please check all that apply)
- Depth gauge
- Timing device/watch
- Buoyancy vest
- BC Inflator hose in use
- Decompression computer

35. EQUIPMENT MALFUNCTION:
- A - None
- B - Regulator
- C - BC Vest
- D - Weight belt
- E - Dry suit
- F - DC Computer
- G - Inflator hose
- H - Contaminated air supply
- I - Equipment was not familiar to you.
- J - Other

Reason:_____

36. TYPE OF DIVE
- Y - Yes
- N - No
- Single
- Repetitive

37. WOMEN, PLEASE RESPOND (up to 2 responses)

When the accident occurred, were you:
- A - Menstruating
- B - On birth control medication
- C - Pregnant
- D - None of the above

38. DIVE LOCATION:

State, Province, or Island._____ Country or nearest country:_____

39. How long ago was your last Dive Trip/Series?

Circle one: Days Weeks Months

40. STRENUOUS EXCERCISE
- Y - Yes
- N - No
- 24 hours predive
- During dive
- 6 hours postdive

41. PREDIVE HEALTH
- A - Nausea/ vomiting
- B - Hangover
- C - Diarrhea
- D - Other
- E - No Problem

42. ALCOHOL

Please check: Number of drinks, beers, or wine
- None
- Night Before
- Predive
- Between Dives
- Post Dive

43. RECREATIONAL DRUG USE

Prior to, between, or after dive
- Y - Yes
- N - No

44. Do you consider yourself physically fit?
- Y - Yes
- N - No

Do you excercise on a weekly basis? (Y or N)

Days per week

45. FATIGUE OR LACK OF SLEEP PRIOR TO DIVE?
- Y - Yes
- N - No

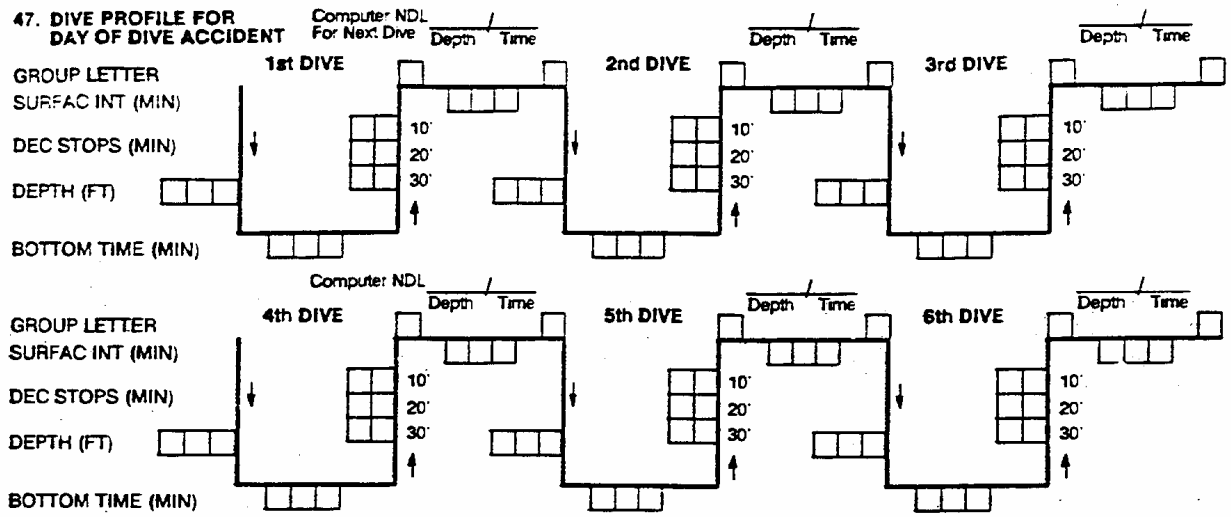
46. DIVE SERIES

Please fill in all that apply up to and including your last dive. If you skipped a day please leave that day blank

	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7
Total # of dives							
Any night dive? (How many)							
Any symptoms? (Y or N)							
A - All no stop dive(s) B - Any safety stop C - Any dive requiring decompression stops							
A - Multilevel (time divided) B - Square							
Deepest Dive (ft.)							

DIVE ACCIDENT OR INCIDENT (con't)

47. DIVE PROFILE FOR DAY OF DIVE ACCIDENT



PRE-CHAMBER INFORMATION

48. INITIAL CONTACT WAS:

- A - DAN Emergency
- B - DAN Non-emergency
- C - Hospital emergency room
- D - Emergency medical service
- E - US Coast Guard
- F - Physician
- G - Dive instructor/shop
- H - Other _____

49. Total delay from symptom onset to contacting DAN or other medical help:

HOURS or DAYS

50. FLYING OR INCREASED ELEVATION AFTER DIVING AND PRIOR TO TREATMENT?

- A - Commercial airliner
- B - Unpressurized aircraft
- C - Med Evac Flight
- D - Mountain elevation
- E - Does not apply

Hours post dive (flew or went into elevation) /

elevation (in feet)

51. SIGNS & SYMPTONS

1st Symptom / 2nd Symptom / 3rd Symptom / 4th Symptom / 5th Symptom / 6th Symptom

- A - Pain
- B - Rash
- C - Itching
- D - Weakness
- E - Numbness/Tingling
- F - Dizziness/Vertigo
- G - Semi-consciousness
- H - Unconsciousness
- I - Restlessness
- J - Extreme fatigue
- K - Visual disturbance
- L - Speech disturbance
- M - **Headache**
- N - Paralysis
- O - Difficulty breathing
- P - Nausea/Vomiting
- Q - Hemoptosis/coughing blood from lungs
- R - Muscle twitching
- S - Convulsions
- T - Hearing loss
- U - Ringing ears
- V - Decreased skin sensation
- W - Bladder problem
- X - Bowel problem
- Y - Personality change
- Z - Difficulty walking/standing
- 1 - Reflex change
- 2 - Other: _____

52. LOCATION: Block A = location of symptom
Then please check (✓)
L = Left R = Right B = Bilateral/Both Sides

1st Symptom / 2nd Symptom / 3rd Symptom / 4th Symptom / 5th Symptom / 6th Symptom

A L R B

- A - Head
- B - Face
- C - Sinus
- D - Eyes
- E - Ears
- F - Neck
- G - Shoulder
- H - Entire arm
- I - Upper arm
- J - Elbow
- K - Forearm
- L - Wrist
- M - Hand
- N - Fingers
- O - Chest
- P - Back
- Q - Upper back
- R - Lower back
- S - Abdomen
- T - Buttock
- U - Groin
- V - Hip
- W - Entire leg
- X - Thigh
- Y - Knee
- Z - Calf
- 1 - Shin
- 2 - Ankle
- 3 - Foot
- 4 - Toes
- 5 - Trunk
- 6 - Generalized
- 7 - Other _____

53. SYMPTOM ONSET:

	HOURS	MINUTES	or	BEFORE SURFACING FROM DIVE
1st Symptom				
2nd Symptom				
3rd Symptom				
4th Symptom				
5th Symptom				
6th Symptom				

54. ANY OF THE SYMPTOMS FROM #51 PRIOR TO THE LAST DIVE?

Y - Yes N - No

If yes, which symptoms?

1st / 2nd / 3rd / 4th / 5th / 6th

Other

Explain _____

55. FIRST AID ADMINISTERED BEFORE HOSPITAL OR CHAMBER HELP WAS RECEIVED?

Y - Yes N - No

- Oxygen
- Aspirin
- Oral fluids
- Head down position/ Trendelenburg

If oxygen was received was delivery by

- A - Demand valve
- B - Freeflow valve
- C - Don't know

PRE-CHAMBER INFORMATION (cont.)

56. HOSPITAL TREATMENT ADMINISTERED

(Please check all that apply):

- ☐ None
- ☐ Oral fluids
- ☐ IV fluids
- ☐ Oxygen
- ☐ Steroids
- ☐ Anticoagulant
- ☐ Aspirin
- ☐ Other medication

_____

_____

57. RELIEF BEFORE CHAMBER TREATMENT?

☐
A - Complete
B - Partial
C - Temporary
D - None

58. IF ANY RELIEF OCCURRED, WHICH SYMPTOMS FROM #51 ABOVE?

(Please check):

1st ☐
2nd ☐
3rd ☐
4th ☐
5th ☐
6th ☐

59. PRE-CHAMBER RELIEF OCCURRED:

☐
A - Without first aid or medical care
B - Following first aid
C - Following pre-chamber hospital care
D - No relief occurred

CHAMBER TREATMENT

60. CHAMBER TREATMENT FACILITY LOCATION

CITY

STATE COUNTRY

Date & Time of Treatment

MONTH/DAY/YEAR

Time _____ AM PM

Name of hyperbaric facility

Treating doctor

Form Completed By

_____

61. TYPE OF CHAMBER
(please check)

Initial Treatment	Retreatment Chamber
☐ Monoplace	☐ Monoplace
☐ Dualplace	☐ Dualplace
☐ Multiplace	☐ Multiplace
☐ No chamber treatment given	

62. TOTAL DELAY FROM SYMPTOM ONSET TO RECOMPRESSION

HOURS ☐ or DAYS ☐

63. INITIAL TREATMENT

☐
A - USN TT4
B - USN TT5
C - USN TT6
D - USN TT6A
E - HART Protocol
F - KINDWALL Protocol
G - 45 fsw 90 min
H - 33 fsw 120 min
I - Other

_____

_____

64. TABLE EXTENSIONS REQUIRED?

☐
Y - Yes
N - No

65. RELIEF AFTER INITIAL TREATMENT OF SYMPTOMS FROM # 51?

1st ☐
2nd ☐
3rd ☐
4th ☐
5th ☐
6th ☐

Please indicate:
A - Complete
B - Partial
C - Temporary
D - None

66. RETREATMENT GIVEN
(Provide up to 3 responses)

TABLE	NUMBER OF TREATMENTS
☐	☐
☐	☐
☐	☐

A - USN TT4
B - USN TT5
C - USN TT6
D - USN TT6A
E - HART Protocol
F - KINDWALL Protocol
G - 45 fsw 90 min
H - 33 fsw 120 min
I - Other

_____

67. RELIEF AFTER HYPERBARIC THERAPY COMPLETED?

☐
A - Complete
B - Partial
C - Temporary
D - Hyperbaric therapy not completed
E - None

68. RESIDUAL SYMPTOMS AFTER HYPERBARIC THERAPY COMPLETED?

☐
A - Pain only
B - Neurologic
C - Hyperbaric therapy not completed
D - None

69. DURATION OF RESIDUAL SYMPTOMS

(Circle one)

☐
DAYS
WEEKS
MONTHS

70. FINAL DIAGNOSIS:

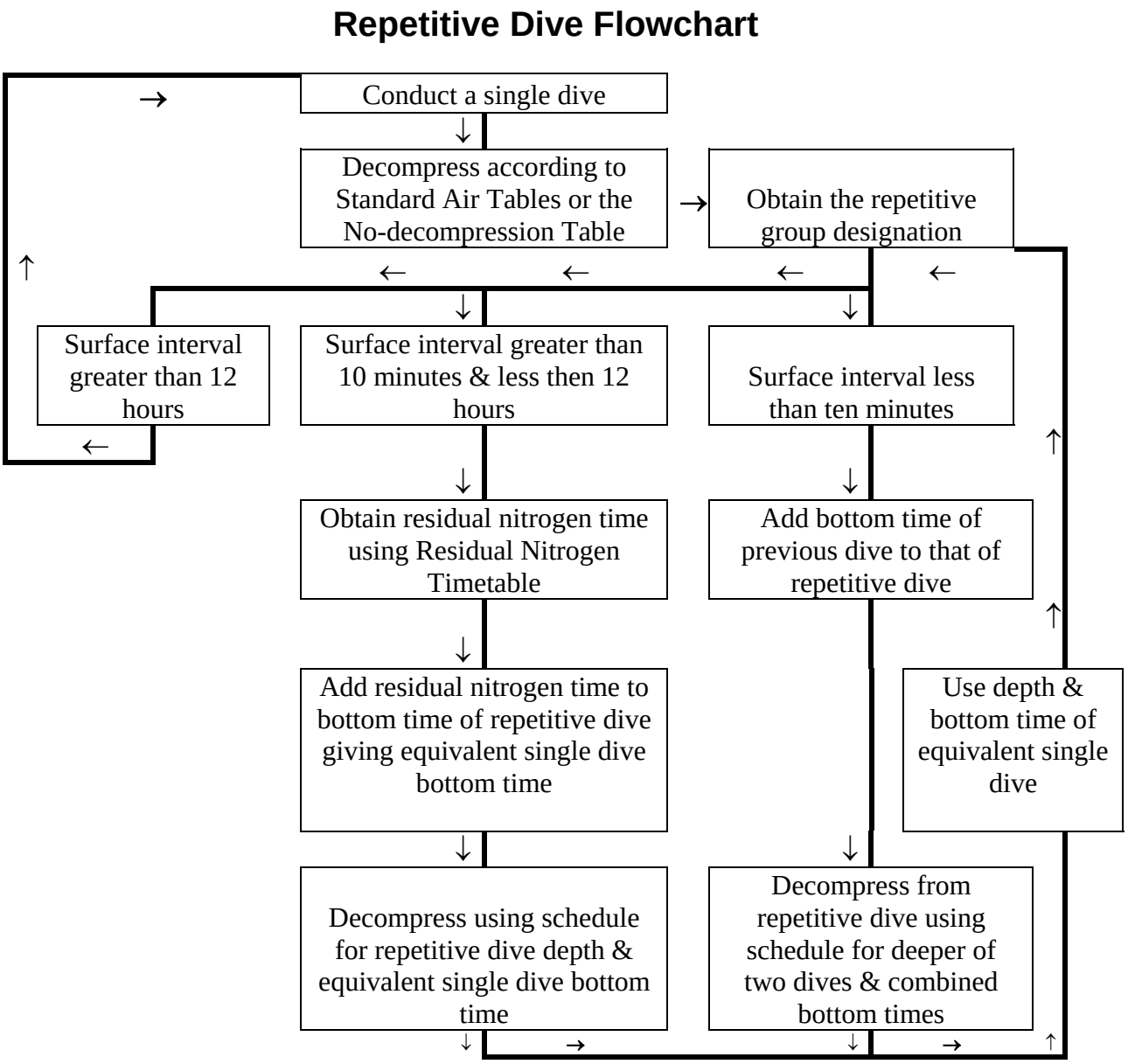
☐
A - DCS I
B - DCS II
C - Air Embolism
D - Pulmonary Barotrauma
O - Other

_____

_____

_____

Appendix L. Repetitive Dive Flow Chart



Appendix M. No Decompression Limits and Repetitive Group Designation Tables for No-Decompression Air Dives

dep=ftft	no deco	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
10		60	120	210	300											
15		35	70	110	160	225	350									
20		25	50	75	100	135	180	240	325							
25		20	35	55	75	100	125	160	195	245	315					
30		15	30	45	60	75	100	120	145	170	205	250	310			
35	310	5	15	25	40	50	60	80	100	120	140	160	190	220	270	310
40	200	5	15	25	30	40	50	70	80	100	110	130	150	170	200	
50	100		10	15	25	30	40	50	60	70	80	90	100			
60	60		10	15	20	25	30	40	50	55	60					
70	50		5	10	15	20	30	35	40	45	50					
80	40		5	10	15	20	25	30	35	40						
90	30		5	10	12	15	20	25	30							
100	25		5	7	10	15	20	22	25							
110	20			5	10	13	15	20								
120	15			5	10	12	15									
130	10			5	8	10										
140	10			5	7	10										
150	5			5												
160	5				5											
170	5				5											
180	5				5											
190	5				5											

OCTOBER 1991------NOAA Diving Manual Source: US Navy (1988)

Residual Nitrogen Timetable for repetitive air dives

															A	0:10
	*Dives after surface intervals of more															12:00*
	than 12 hours are not repetitive dives													B	0:10	2:11
	Use actual bottom times in the														2:10	12:00*
	Standard Air Decompression Table												C	0:10	1:40	2:50
	to compute decompression for such													1:39	2:49	12:00*
	dives. See sec. 14.6.2.3 for											D	0:10	1:10	2:39	5:49
	instructions for this table.												1:09	2:38	5:48	12:00*
											E	0:10	0:55	1:58	3:23	6:33
	**If no residual nitrogen time is given then the											0:54	1:57	3:22	6:32	12:00*
	repetitive group does not change.									F	0:10	0:46	1:30	2:29	3:58	7:06
											0:45	1:29	2:28	3:57	7:05	12:00*
									G	0:10	0:41	1:16	2:00	2:59	4:26	7:36
										0:40	1:15	1:59	2:58	4:25	7:35	12:00*
								H	0:10	0:37	1:07	1:42	2:24	3:21	4:50	8:00
									0:36	1:06	1:41	2:23	3:20	4:49	7:59	12:00*
							I	0:10	0:34	1:00	1:30	2:03	2:45	3:44	5:13	8:22
								0:33	0:59	1:29	2:02	2:44	3:43	5:12	8:21	12:00*
						J	0:10	0:32	0:55	1:20	1:48	2:21	3:05	4:03	5:41	8:41
							0:31	0:54	1:19	1:47	2:20	3:04	4:02	5:40	8:40	12:00*
					K	0:10	0:29	0:50	1:12	1:36	2:04	2:39	3:22	4:20	5:49	8:59
						028	0:49	1:11	1:35	2:03	2:38	3:21	4:19	5:48	8:58	12:00*
				L	0:10	0:27	0:46	1:05	1:26	1:50	2:20	2:54	3:37	4:36	6:03	9:13
					0:26	0:45	1:04	1:25	1:49	2:19	2:53	3:36	4:35	6:02	9:12	12:00*
			M	0:10	0:26	0:43	1:00	1:19	1:40	2:06	2:35	3:09	3:53	4:50	6:19	9:29
				g0:25	0:42	0:59	1:18	1:39	2:05	2:34	3:08	3:52	4:49	6:18	9:28	12:00*
		N	0:10	0:25	0:40	0:55	1:12	1:31	1:54	2:19	2:48	3:23	4:05	5:04	6:33	9:44
			0:24	0:39	0:54	1:11	1:30	1:53	2:18	2:47	3:22	4:04	5:03	6:32	9:43	12:00*
	O	0:10	0:24	0:37	0:52	1:08	1:25	1:44	2:05	2:30	3:00	3:34	4:18	5:17	6:45	9:55
		0:23	0:36	0:51	1:07	1:24	1:43	2:04	2:29	2:59	3:33	4:17	5:16	6:44	9:54	12:00*
Z	0:10	0:23	0:35	0:49	1:03	1:19	1:37	1:56	2:18	2:43	3:11	3:46	4:30	5:28	6:57	10:06
	0:22	0:34	0:48	1:02	1:18	1:36	1:55	2:17	2:42	3:10	3:45	4:29	5:27	6:56	10:05	12:00*
	Z ↓	O ↓	N ↓	M ↓	L ↓	K ↓	J ↓	I ↓	H ↓	G ↓	F ↓	E ↓	D ↓	C ↓	B ↓	A ↓
10	**	**	**	**	**	**	**	**	**	**	**	**	279	159	88	39
20	**	**	**	**	**	**	**	399	279	208	159	120	88	62	39	18
30	**	**	469	349	279	229	190	159	132	109	88	70	54	39	25	12
40	257	241	213	187	161	138	116	101	87	73	61	49	37	25	17	7
50	169	160	142	124	111	99	87	76	66	56	47	38	29	21	13	6
60	122	117	107	97	88	79	70	61	52	44	36	30	24	17	11	5
70	100	96	87	80	72	64	57	50	43	37	31	26	20	15	9	4
80	84	80	73	68	61	54	48	43	38	32	28	23	18	13	8	4
90	73	70	64	58	53	47	43	38	33	29	24	20	16	11	7	3
100	64	62	57	52	48	43	38	34	30	26	22	18	14	10	7	3
110	57	55	51	47	42	38	34	31	27	24	20	16	13	10	6	3
120	52	50	46	43	39	35	32	28	25	21	18	15	12	9	6	3
130	46	44	40	38	35	31	28	25	22	19	16	16	11	8	6	3
140	42	40	38	35	32	29	26	23	20	18	15	12	10	7	5	2
150	40	38	35	32	30	27	24	22	19	17	14	12	9	7	5	2
160	37	36	33	31	28	26	23	20	18	16	13	11	9	6	4	2
170	35	34	31	29	26	24	22	19	17	15	13	10	8	6	4	2
180	32	31	29	27	25	22	20	18	16	14	12	10	8	6	4	2
190	31	30	28	26	24	21	19	17	15	13	11	10	8	6	4	2

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